Microbial biodegradation of polyhydroxyalkanoates in the marine environment

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Abstract

Among actual bioplastics, polyhydroxyalkanoates (PHA) has raised great interest as a substitute to persistent petroleum based plastic materials. Naturally produced by numerous bacteria as a form of carbon storage, PHA show good signs of biodegradability in natural ecosystems.

Here, we evaluate the influence of the chemical structure (eight formulations of short and medium-chain-length PHA) on the biodegradability of PHA in the marine environment. We used an original miniaturized experimental design that allowed transdisciplinary analyses (dissolved inorganic carbon production, oxygen consumption, heterotrophic bacterial activity, microbial biomass and diversity, molecular weight, production of oligomers and monomers). After 30 days of incubation with a natural community, we observed different signs of biodegradability for the eight PHA. In particular, higher microbial activity was monitored in short-chain-length (scl) sample than in medium-chain-length (mcl).

To better understand scl-PHA biodegradation by marine microbes, radio-labeled 13C-PHB was incubated with natural communities for 90 days. Microbial activity and biomass were monitored, and DNA was extracted on days 5, 13, 30 and 90 of incubation. DNA-Stable isotope probing (DNA-SIP) was used in order to describe degrading and opportunist communities. Metabarcoding analyses highlighted taxonomic differences between 13C and 12C fractions, and metagenomic analyses allowed us to decipher the functional difference between the two fractions.

Keywords: plastisphere, biodegradation, polyhydroxyalkanoates, DNA, stable isotope probing

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